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second layer of soft brown stone, all sand, the surface stratum being hardened mud.

The latest, and so far one of the most interesting discoveries, is that of a *Cycadites*, in reference to which Dr. Lesquereux writes:

"Now, we have as yet not seen any species of this genus in our Cretaceous. Species of *Cycas* and *Zamites* are abundant, especially in the Jurassic. They are seen also, less numerous, however, in the lowest Cretaceous, and very rarely in the upper and middle Cretaceous. Heer has described one species only from the upper Cretaceous of Greenland," etc.

This would seem to indicate that Palms may have formed part of the forest landscape of ancient central Kansas.

While these researches were being made in Clay county, Mr. Charles Sternberg, a most indefatigable explorer, has sent scores of fine specimens from Fort Harker. In former years Prof. Mudge has made most interesting discoveries on the Saline; and Dr. Lesquereux, in 1872, explored the Dakota group from southern Nebraska far into Kansas. The result of these explorations, thus far, has been to develop the fact, that far back in the dim ages of the forgotten past, there grew and flourished here in central Kansas vast forests, comprising most of the trees that now exist only in the temperate zones, with many others almost as exclusively tropical or semi-tropical; that these forests grew on long, low lands, in the midst of, or on the borders of, the great Cretaceous sea, which then rolled its heaving billows over all of what is now western Kansas. The presence of so many tropical and sub-tropical remains proves that a mild and equable climate obtained from the Gulf of Mexico to the arctic regions, as the fossil remains from the Cretaceous beds prove the existence of a warm, shallow sea.

In several places over the region I have explored, I have found impressions of wood and bark—hundreds of these casts stamped indelibly upon the now solid rock, the wood itself being very rarely preserved. Very few of these impressions of wood are ever found in the same deposit with the leaves, indicating, perhaps, that these fragments may have drifted to some distance from the spot whereon the trees grew. I have seen, in a few instances, rocks of hardened clay and sand, covered with sun-cracks, showing conditions analogous to those which now obtain along our own shores.

Thus, this long line of hills and bluffs now known as the "Dakota group" indicates an ancient shore-line, covered with heavy forests, enjoying a mild, even climate, animated and irradiated by the same sun, moon and stars that now cheer and enliven our landscapes; and, probably, the haunts of many of the monsters whose bones we find fossilized in the chalk and shale of the Cretaceous beds. We have yet, I think, no traces of feathered inhabitants of these primeval forests. No animals roamed beneath their silent shades. They lived, fulfilled their destiny, and passed away, leaving behind them imperishable records of their life and usefulness—literally, "Footprints on the sands of time."

THE RIVER BLUFFS.

By Prof. John D. Parker, of Kansas City.

Chief among influences moulding a people are those derived from Nature. Like odors distilled from flowers, or colors playing in sunbeams, the subtle powers of Nature elude analysis. But as the crystal lake mirrors

the landscape which environs it, so Nature is reflected in any people. In the mountains of Greece we find the greatest æsthetical development of the Old World. Italy with its sunshine and flowers, its brilliant skies and outdoor life, developed an indolent but happy people. The canton sprang up amidst the eternal mountains and Alpine glaciers of Switzerland. England, with its comparatively immense shore-line, its fogs distilled from the Gulf stream, and its pastoral lands, developed a strong but phlegmatic race. The New England hills naturally moulded a people possessing the highest and best traits in man. Muscular development was required to subdue Nature, intelligence evolved in developing and applying science to industry, culture was inwrought and polished manners ground out by the attrition of society, and art was engendered by the luxuries which Nature offers to those who hang over with delight and feast upon landscapes. During our civil strife, the love of liberty was found strongly intrenched in the mountainous districts of West Virginia, North Carolina and East Tennessee.

It is the purpose of this paper to inquire, What has Nature done for the higher development of the dwellers on the great central plains of the North American continent?

In wealth and variety of soil the great plains are justly celebrated. Nothing can exceed the depth and fertility of the alluvial deposits. The cereals of the temperate zone grow with almost spontaneity. The sacred phrase has its counterpart, a thousand cattle on a hill. With mineral resources Nature has stored her secret chambers. The offerings of grains and fruits and flowers are in profusion. But what keeps a people living amidst such luxuries from indolence and retrogradation?

Among Nature's opposing forces may be placed river bluffs, an American term applied to cliffs or high banks overhanging streams. The river bluffs constitute an important element in the physical features of the West. The Mississippi river and its numerous and powerful affluents nearly always flow between these bluffs, rising in places as massive walls, and sloping back sometimes for miles from the river on either side with decreasing undulations, and melting away at last in the level prairie. Counting both banks, this system of rivers alone would give a single line of elevations meandering through the great plains something like twenty thousand miles in length, and rising at some points to a height above the river of five hundred feet.

The geology of the river bluffs rests on the following dynamic principles. In an open country like the prairies, rivers possess two elements—a channel, and a flood-plain. During the winter season, and some months in summer, the stream is confined within the channel. But during freshets, and particularly the June freshet, which is swollen by mountain snows, the stream rises and spreads over the flood-plain. Now should the interior of the continent be elevated say a hundred feet by internal forces, the coast line remaining the same, the river would have a greater fall, quicker flow, and more eroding power. A new channel and a new flood-plain would be cut, both of less width, leaving the outer margins of the old flood-plain as an elevated terrace. And the walls of the original suture, or outer banks of the stream, would be left by the receding water to be elevated by such successive epochs into river bluffs. And the partings or lips of any suture in the original crust would be slightly turned up by escaping steam or gases, or outward pressure of the yielding mass beneath, leaving the bluff elevated above the surrounding prairie. Four such elevations have taken place since the rivers of the eastern portion of the continent began to flow, and three since the Mississippi began to pursue its course toward the Gulf. As the

geological elevation has been greatest toward the interior and western portions of the continent, the eroding power of rivers has proportionally increased, causing the river bluffs to become more prominent as physical features of the country as we ascend the rivers, just as we shall see where they are needed.

The meteorology of the river bluffs is an important element to those dwelling on the great plains. People always living among hills crowned with forests do not realize the force or constancy of the winds in a level prairie country. At Lawrence, Kansas, for example (a place not exposed as much as many points farther west), the self-registering anemometer on the University building, situated on Mount Oread, furnishes the following record: During the year 1875 the wind traveled 145,316 miles, which gives a mean daily velocity of over 398 miles, and an hourly velocity of over 16 miles. These total winds, flowing uniformly over the whole year, would give the people of Lawrence a constant current of air between a fresh breeze and a strong wind. On January 8, 1875, at the same place, the wind attained a velocity of seventy-five miles an hour, a violent gale, only one remove from a hurricane.

The same general belts of wind, running east and west, prevail around the globe. But the forest-crowned hills of New England and the Middle States drive these currents up into the higher regions of the atmosphere. Now the river bluffs are the natural wind-breaks of the great central plains, and without them the prairies would be a bleak, an almost uninhabitable plateau.

Many have observed that rain storms follow streams, without understanding the principles involved. Streams saturate the contiguous air, which again yields its moisture to a condensation, which does not reduce the dryer air lying outside at a distance from the river to the dew-point. In a similar manner, a super-saturated sponge will give forth moisture to a pressure under which a partially saturated sponge would not yield a drop. A cool current of air passing over the country would thus cause the condensation of vapor, or the ever-forming rain cloud, to appear to travel along river courses. And the greater precipitation of moisture along river courses has been one essential element in the growth of forests, frequently covering river bluffs to give them more force as wind-breaks.

The horticulture of the river bluffs is worthy a passing thought. The pursuits of any people determine to some extent their character. Horticulture is a scientific pursuit involving mind, and possessing elevating tendencies. Now the river bluffs are the natural home of the horticulturist. The conditions of soil and climate determine this pursuit almost to the exclusion of cereals. The apple, pear, plum, peach, quince and apricot love the bluffs, and the small fruits flourish. Notably the grape finds its home among the bluffs. We see its rich purple clusters peeping out beneath leafy trellis bars up the sides of almost inaccessible heights. A horticultural people sandwiched in all through the great plains, and mingling freely with neighboring communities while discussing cognate topics, are not devoid of influence which tends to lift a people into higher forms of living. When the year comes to his prime and bears to our homes his rich stores, ripened with dew, sunshine and shower, we dream of Eden, the ideal of human earthly perfection.

The æsthetics of the river bluffs must not be neglected. The absence of this element is dangerous to any people. When painters cease to study Nature's habitudes, and galleries of art are neglected, when poets forget to draw from their inspiration and repeat her voices, decay falls on a

people. In the great plains almost the only elevations are found along the rivers. From these heights the prairies with their green carpets richly ornamented with flowers unfold before us. Nothing compares to a prairie scene except the mighty ocean. The blue vault hangs over us more cerulean than in Eastern climes, the river winds its silver thread between the bluffs until it seems to be broken, and the undulating prairie rolls all around us like the ocean. With such scenes ever before a people can there be decay in poetry, painting or sculpture?

The home life of the river bluffs is an essential element. Nearly all our Western cities and smaller towns, containing quite a proportion of the population, are found along the rivers, nestled in the bluffs. The luxury of hills is thus brought to our very doors. No one is in condition to enjoy this luxury until deprived of it. When hills are piled on hills, as in some of the States, there is too much of a good thing. Desserts of rich food eaten daintily become a luxury. River bluffs are the desserts of our broad prairies, with which Nature has stored her ample board. The prairies satisfy our physical wants; the bluffs feast our souls. The prairies pour in their ample products until all our store-houses are filled beyond measure. The bluffs lift up our homes and spread the board with ambrosial food. Lifted above the earth we live nearer the gods. We drink in the royal landscape around us, of which poets and painters may only dream. The luxury of a prairie home nestled in the bluffs cannot be portrayed.

At the mouth of the Kansas river, Nature evidently planned a city. From this point the railway system naturally radiates. But the frowning bluffs seem to forbid it. Gradually the bluffs melt away to fill the deep ravines. Easily-graded streets leave terraces on either side, to be the sites of comfortable homes, while the crests, with finer views, are crowned with mansions. We love homes lifted a little above the busy street on terraced heights, surrounded with fountains and trees, fruits and flowers. Such homes are being built all along the Father of Waters—rural retreats of luxury, taste and culture.

To the great central plains of North America, the river bluffs are Nature's richest gift. For ages Nature was slowly moulding them, and setting them as watch-towers through all the land. They shield man from the elements which, unobstructed, would desolate his home; they furnish the conditions of a higher rural life; they disclose rich minerals, which Nature has stored in her secret chambers; they reveal the beauties of Nature hidden in landscapes; they furnish sites for homes of comfort and luxury; they tend to lift a people, in a word, out of a dead level, giving the power of elevation from which flows intelligence, culture, and true refinement; they open a fountain of living waters to slake the thirst of coming millions. The gods dwelt in Mount Olympus, we are told, in the olden time; so here diviner forms seem to descend to dispense to men their richest favors. Here are the lines of light that shall grow brighter and broader, we trust, until the whole land shall be enlightened and filled with true knowledge. Here shall the graces descend into human habitations, filled with sunshine and gladness, as long as rivers flow murmuring to the sea.